Current Research

Accuracy of Dietary Recall Using the USDA Five-Step Multiple-Pass Method in Men: An Observational Validation Study

JOAN M. CONWAY, PhD, RD; LINDA A. INGWERSEN; ALANNA J. MOSHFEGH, MS, RD

ABSTRACT

Objective This observational validation study was conducted under controlled conditions to test the accuracy of dietary recall in normal weight, overweight, and obese men using the USDA five-step multiple-pass method for dietary recall.

Design Cross-sectional analysis of actual and recalled intake of food during 1 day.

Subjects/setting Forty-two men ranging in age from 21 to 65 years and in body mass index from 21 to 39 kg/m^2 who lived in the metropolitan Washington DC area were studied.

Intervention The subjects selected and consumed all meals and snacks, for 1 day, from a wide variety of foods provided at a human study facility.

Main outcome measures Actual and recalled energy, protein, carbohydrate, and fat intakes were determined by direct observation and by a 24-hour dietary recall, respectively. Dietary recall was determined via telephone administration of the USDA five-step multiple-pass method the following day.

Statistical analyses performed Analysis of variance and covariance tested the overall accuracy of recall and the effect of body mass index on dietary recall. Bland-Altman plots were used to assess bias in recall of food intake.

Results In this population of men, there were no significant differences between actual and recalled intakes of energy (3,294±111 and 3,541±124 kcal/day), protein (117±5 and 126±5 g/day), carbohydrate (414±16 and 449±16 g/day), or fat (136±7 and 146±8 g/day), respectively. Accuracy of recall was not related to body mass index in that the obese men recalled food intake as accurately as the nonobese men. The energy intake of these men was significantly correlated (r=0.57, P<.05) with their estimated energy requirements. Significant interindividual variation in accuracy of recall was found.

Conclusions Under controlled conditions, the USDA five-step multiple-pass method can accurately assess intakes of energy, protein, carbohydrate, and fat in a population of men regardless of their body mass index. Researchers and clinical dietitians need to continue to examine factors that influence underreporting and overreporting of food intake by the multiple-pass 24-hour recall method.

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Since 1894 (1) Congress has mandated that the United States Department of Agriculture (USDA) survey food intake in Americans. Although the early studies were small in scale, by 1955 the USDA was conducting nationwide surveys on either a household or an individual basis. The USDA survey was most recently called the Continuing Survey of Food Intake by Individuals (CSFII) and was conducted in 1985 to 1986, 1989 to 1991, 1994 to 1996, and 1998 (2).

The USDA has conducted national food consumption surveys for nearly a century, and it has also maintained a research program in dietary assessment methodology. The most recent product is a standardized dietary instrument for collecting 24-hour dietary recalls called the USDA Automated Multiple-Pass Method, a five-step multiple-pass 24-hour dietary recall method (3-6). Since January 2002, this method has been used jointly by the USDA Food Surveys Research Group and the Department of Health and Human Services (DHHS), National Center for Health Statistics for dietary data collection called "What We Eat in America" as part of the continuing National Health and Nutrition Examination Survey (NHANES). Data from national surveys are critical for the evaluation of a wide array of public food and health programs and policies, as well as for nutrition research at federal, state, and local levels. Given the critical uses of these dietary data to ensure the public's health, safety, and well-being, the collection of these data must be completed using scientifically tested methods and systems that result in highly accurate data.

In a study conducted in a population of children, Johnson and colleagues (7) compared energy intake estimates based on a multiple-pass method with energy expenditure measurements from doubly labeled water and found that this multiple-pass method provided valid group estimates of energy intake. Jonnalagadda and colleagues (8) also used a multiple-pass 24-hour dietary recall

J. M. Conway is a Research Chemist in the Diet and Human Performance Laboratory, and L. A. Ingwersen is a Home Economist and A. J. Moshfegh is the Research Leader in the Food Surveys Research Group, Beltsville Human Nutrition Research Center, United States Department of Agriculture, Agricultural Research Service, Beltsville, MD.

Address correspondence to: Joan M. Conway, PhD, RD, USDA: ARS: BHNRC, Diet and Human Performance Lab, Bldg 307B, Room 213, Beltsville, MD 20705.

E-mail: conway@bhnrc.arsusda.gov

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method and found an 11% underreporting in men and a 1.3% overreporting in women who received food in a supervised setting. In a previous study from our laboratory, using the USDA five-step multiple-pass 24-hour dietary recall method, 49 women recalled food intake within 10% of actual intake. Mean food intake was overestimated by normal and overweight women; however, obese women accurately recalled their food intake (6).

The present study was conducted as an observational validation of this dietary recall methodology in men. We asked four primary questions. Under controlled conditions, (a) can the USDA five-step multiple-pass method be used by men to accurately assess energy, protein, carbohydrate, and fat intake?; (b) are macronutrients, specifically carbohydrates, and fats selectively underreported and/or overreported?; (c) does body mass index (BMI, varying from 20 to 45) affect accuracy of recall in men, ie, will normal weight, overweight, and obese men report their food intake with the same degree of accuracy?; and (d) could the intake of energy from this 1 day be at all representative of habitual intake. Our hypotheses were that recalled intake would be an underestimate of actual intake for energy, protein, carbohydrate, and fat; that obese men would underreport food intake to a greater extent than their normal weight and overweight counterparts; that there would be selective underreporting of fat intake; and that energy intake on this 1 day would be significantly different from estimated energy requirements.

METHODS

General Experimental Design

Using a cross-sectional design, the study compared actual food intake, as determined by direct observation, and recalled food intake, as determined by 24-hour dietary recall using the USDA five-step multiple-pass method, in a group of adult men. Food intake during only 1 day was studied to maximize sample size and to minimize any possible learning effect that would be introduced if the study were conducted over multiple days. Each man served as his own control.

Because of the requirements of informed consent, we told prospective subjects that the purpose of the study was to test the foods prepared in the Beltsville Human Nutrition Research Center (BHNRC) Human Study Facility (HSF) and to study food selection and recall in men. A debriefing interview via the telephone (described below) was listed among the time requirements of the study, but no detail was provided in advance as to the nature of the debriefing process.

We studied each subject during a 2-week period. During the first week, the subjects reported to the BHNRC for measurement of body fat by dual-energy x-ray absorptiometry (DXA). During 1 day of the second week the subjects ate three meals during the day at the BHNRC HSF. They were asked to select from a wide assortment of food items in a cafeteria-style display and to consume as much as they wanted. Each subject ate alone at a time they selected. Subjects were scheduled 45 minutes apart to allow each sufficient time to select and consume food in a relaxed manner. Snacks were available for takeout. Subjects were instructed to consume only food provided by the BHNRC HSF during the study day. Subjects returned to their work or attended to personal business between meals, ie, they were not housed at BHNRC.

After dinner each subject received an envelope containing a USDA Food Model Booklet (9), and some measuring guides including a ruler and measuring cups and spoons, and was told that the materials would be needed during the debriefing interview. They were reminded of the time for the debriefing telephone call, but no instructions on the use of the Food Model Booklet were provided at that time. Each participant received a 30- to 45-minute debriefing telephone call the following afternoon; this call included a dietary recall as described below.

Subjects and Recruitment

Data were obtained from a nonrandom sample of 45 men who were recruited by advertisements in local newspapers and by E-mail at the USDA, Beltsville, MD, and at the NASA Goddard Space Flight Center, Greenbelt, MD. Nutrition or health care professionals were excluded. Other exclusion criteria included having diabetes, chronic consumption of medications that affect appetite, and current participation in a weight loss regimen. Subjects taking prescription medications for hypertension, hypercholesterolemia, headache, and osteoarthritis were included.

The Institutional Review Board at the Johns Hopkins University School of Public Health approved the study protocol. Each potential subject gave written informed consent and received a medical evaluation by the same physician, including a medical history and measurement of blood pressure, height, and weight.

Body Composition

Weight was determined on an electronic balance to the nearest 0.01 kg, and height was measured to the nearest 0.1 cm with a stadiometer. BMI was defined as weight (kg)/height (m^2). Percent body fat was determined at the BHNRC by DXA (Model QDR-4500A, software version 9.80D, 1997 Hologic Inc, Bedford, MA). The subjects were asked to consume nothing for 3 hours before the scan, to dress in metal-free clothes, and to remove jewelry.

Body weight was collected during the recruitment phase of the study and again between 2 and 6 weeks later on the day of the DXA measurement. The difference between these two weights was used as an estimate of body weight maintenance.

Menu and Portion Design

The same foods were offered to each subject and are listed in Figure 1. Weight, volume, or package size for every food was determined in advance by the study investigators. Before selection and consumption by the subjects, all foods prepared in the HSF were weighed. Label weights were used for commercially prepared and packaged portion-controlled food items.

In an attempt to allow for differences in individual energy requirements and personal preferences, more than one serving of each item was available. For example, bread, luncheon meats, bacon, and sausage were packaged singly, but four to six packages of each item were

Breakfast	Lunch	Dinner
Original english muffin	White bread	Dinner roll
Whole wheat english muffin	Whole wheat bread	Garlic breadstick
Bagel, plain	Rye bread	Vegetable lasagna
White bread	Sliced ham	Baked chicken breast
Whole wheat bread	Sliced turkey	Chicken gravy
Scrambled egg	Sliced bologna	Beef tips
Bacon	Sliced American cheese	Beef gravy
Sausage	Macaroni and cheese	Rice
Powdered mini-donuts	Peanut butter	Noodles
Chocolate-covered mini-donuts	Fruit jelly	Baked potato
Sugar-coated corn flakes	Frozen pizza	Broccoli
Bran flakes with raisins	Lettuce for salad or sandwich	Green beans
Wheat and rice flakes	Tomato slices	Corn kernels
Orange juice	Raw baby carrots	Lettuce for salad
Apple juice	Raw celery sticks	Tomato slices
Navel orange	Mustard	Raw baby carrots
Delicious apple	Mayonnaise	Raw celery sticks
Cream cheese, regular or light	Italian dressing, regular or fat-free	Italian dressing, regular or fat-free
Butter	Ranch dressing, regular or light	Ranch dressing, regular or light
Margarine, regular or light	Tomato juice	Tomato juice
Fruit jelly	Butter	Butter
Tea and decaf tea	Margarine, regular or light	Margarine, regular or light
Coffee and decaf coffee	Apple juice	Apple juice
Milk, reduced-fat, low-fat, whole	Milk, reduced-fat, low-fat, whole	Milk, reduced-fat, low-fat, whole
Sugar	Soda—cola, regular or diet	Soda—cola, regular or diet
Artificial sweetener	Soda—lemon-lime, regular or diet	Soda—lemon-lime, regular or diet
Bottled water	Potato chips	Potato chips
Salt and pepper	Pretzels	Pretzels
	Chocolate candy	Chocolate candy
	Chocolate, caramel, and peanut candy	Chocolate, caramel, and peanut candy
	Shortbread cookies	Shortbread cookies
	Fig bar cookies	Fig bar cookies
	Chocolate cake, chocolate frosting	Chocolate cake, chocolate frosting
	Apple pie	Apple pie
	Ice cream, vanilla	Ice cream, vanilla
	Chocolate syrup	Chocolate syrup
	Canned peaches	Canned peaches
	Navel orange	Navel orange
	Delicious apple	Delicious apple
	Tea and decaf tea	Tea and decaf tea
	Coffee and decaf coffee	Coffee and decaf coffee
	Sugar	Sugar
	Artificial sweetener	Artificial sweetener
	Bottled water	Bottled water
	Salt and pepper	Salt and pepper

Figure 1. Food items offered at each meal from cross-sectional study comparing recalled food intake and actual food intake.

available. Items such as sugar, yogurt, cereal, cream cheese, jelly, margarine, butter, salad dressing, potato chips, pretzels, candy, cookies, canned fruit, pizza, soft drinks, and water were offered in commercially prepared portion-controlled packaging, but three or more packages of each item were available. Food items were available for snacking and takeout. Subjects were instructed to eat as much or as little as they chose. Foods varying in fat, dietary fiber, and nutrient density were offered at each meal.

Menus were presented to the subjects by a dietetics professional on their arrival. The subjects were instructed to select foods from a cafeteria-style display case. As inconspicuously as possible, food selection was observed by the dietetics professional. Afterward, foods consumed and uneaten were recorded by the dietetics professional. Plate waste was weighed and measured, and the amounts of foods on the actual food intake record were adjusted accordingly.

Uneaten take-home items were returned the day after the debriefing telephone call, along with the measuring guides and the Food Model Booklet. Adjustments to the actual food intake record were made if necessary.

Dietary Recall

The USDA five-step multiple-pass method (4-6) was used in a telephone dietary recall the day after each man ate at the HSF. The same trained interviewer administered the recall to all subjects. First the subjects were familiarized with the Food Model Booklet, and then they were led through the interview step by step. The USDA multiple-pass method consists of five steps: (a) the quick list, which is an uninterrupted listing by the subject of foods and beverages consumed; (b) the forgotten foods list, which queries the subject on categories of foods that have been documented as frequently forgotten; (c) a time and occasion at which foods were consumed; (d) the detail cycle, which elicits descriptions of foods and amounts eaten aided by the interactive use of the USDA Food Model Booklet and measuring guides; and finally (e) the final probe review.

The USDA Food Model Booklet (9) was used to assist in portion-size estimation of consumed foods. It has eight sections: (a) the forgotten foods list, (b) glasses and mugs, (c) bowls, (d) mounds, (e) circles, (f) grid and thickness blocks, (g) wedges, and (h) shapes and chicken pieces.

Coding of Food Intake

The USDA's Food Coding Database (10) was used to code all food data, including the actual and recalled food intake. Portion sizes consumed were entered in gram weights, and each food was assigned a code from the database. Nutrient composition of the food consumed and reported was determined using the USDA's Survey Nutrient Database (11). This database provides the nutrient composition, including the energy, protein, fat, carbohydrate, and mineral content of foods commonly consumed in the United States.

Statistics

Statistical analyses were performed with SAS (version 8.2, 2001, SAS Institute Inc, Cary, NC). The significance level was set at α=.05. The percentage of dietary energy provided by protein, carbohydrate, and fat was calculated. Simple linear correlation analyses and Student's t tests were conducted as necessary to address research objectives. Statistical methods described below were identical to those used in an earlier study (6).

A common statistical method of comparing two methods for assessing the same parameter, a Bland-Altman plot (12,13), was prepared to detect possible bias between actual and recalled energy intake. As described by Bland and Altman (12,13), the limits of agreement were set as two standard deviations of the difference above and below the mean difference.

A repeated measures ANOVA was conducted, using the compound symmetry (ie, type=cs) option in the mixed model ANOVA (the SAS Proc Mixed), both to accurately model the correlation between and to compare actual and recalled intakes reported by the same subject. To further clarify the accuracy of recall, BMI was added to the repeated measures ANOVA as a covariate. The resulting repeated measures analysis of covariance (ANCOVA) modeled actual and recalled values for energy, protein, carbohydrate, and fat as linear functions of BMI, testing the effect of an individual's BMI on actual and recalled intake values. Subsequently, comparisons of recalled vs actual intakes were obtained from the repeated measures ANCOVA using least-squares mean estimates at chosen BMI values. The specific BMI values were representative of men who were normal weight (BMI=22.2), overweight (BMI=27.5), and obese (BMI=36.7). These values were chosen for the purposes of estimating recall accuracy among these three groups and are identical to those used in a previous study in a population of women (6).

As a means of assessing whether the intake on this 1 day could possibly be representative of habitual intake, we made two comparisons. First, estimated energy requirements (EER) were calculated from the equations developed by the National Academy of Sciences, Institute of Medicine, Food and Nutrition Board (14). The EER equation for men 19 years and older is: $=662-(9.53\times\text{Age [y]})+\text{PA}\times(15.91\times\text{Weight [kg]}+539.6\times\text{Height [m]})$, where PA=the physical activity coefficient as defined by the Institute of Medicine (14). We assigned a PA to each man based on reports of the amount of time per day spent in sedentary, moderate, and vigorous physical activity. Again we used a Bland-Altman plot to compare actual energy intake and EER.

Secondly, to allow comparison with previously published studies (15-17), we calculated the energy intake to basal metabolic rate (EI:BMR) ratios for the actual energy intakes. This EI:BMR ratio was suggested by several studies (15-17) to establish EI cut-offs below which a person of a given sex, age, and body weight could not live a "normal lifestyle" (15). The cut-off for the minimal plausible ratio for habitual EI:BMR (using estimated BMR) within 99.7% confidence limits for a population of 50 was reported as 1.38×BMR (15). To do this we estimated BMR using the equations published in 1985 by the United Nations Food and Agriculture Organization and the World Health Organization (18).

RESULTS

Subject Characteristics

The participants were white Americans who varied in body size and percent body fat, age, salary, and education (Table 1). The lowest education level was 12 years, and the average education level was 14 years. Except for one man, all of the participants were employed or retired and receiving a pension. In this group of men, the average income ranged from $46,000 to $50,000 per year.

Body Composition

In this population, BMI was significantly correlated with fat mass (r=0.79, P<.0001), validating the selection of BMI as the surrogate for body fatness in this discussion. On average this population was overweight; only 12 men had a BMI<25, although 19 men had BMIs ranging from ≥25 to ≤30, and 11 men had BMIs>30. There was a maximum of 6 weeks between the medical screening and measurement of body composition; the mean difference in body weight was −1.05±0.24 kg, suggesting that the men were at a stable body weight.

Table 1. Demographic characteristics of study subjects, including weight, height, body composition, education, and income (n=42)

	$\bar{x}\pm$SEM[a]	Range
Age (y)	45.9±1.7	21-65
Height (m)	1.78±0.11	1.58-1.92
Weight (kg)	87.7±2.1	58.3-120.3
Body mass index (kg/m^2)	27.6±4.5	20.8-39.2
Lean body mass (kg)	63.2±1.1	43.5-83.3
Body fat (kg)	22.3±1.2	6.7-45.7
Percent body fat	24.7±0.9	8.9-38.1
Mean education[b] (y)	14	12-20
Mean income[b] (US dollars)	46,000-50,000	0-115,000

[a]$\bar{x}\pm$SEM=means±standard error of the mean.
[b]Represents data that were collected by range; therefore, standard errors of the mean are not possible.

Accuracy of Recall

The recalled and actual intakes for energy, protein, carbohydrate, and fat for the study population are given in Table 2. There was a threefold range in the actual intake of energy, and similarly protein, carbohydrate, and fat intakes varied greatly among the participants. The greatest mean difference between recalled and actual intakes was for carbohydrates (9.3%). There was no selective overreporting or underreporting of protein, carbohydrate, or fat, in that there was a tight range of 8.0% to 9.3% for the mean differences between recalled and actual consumption for all of the macronutrients.

Nine men reported consuming food from home despite our request to limit their intake to foods we provided during this 1 day of study. The food items consumed at home (and number of people who consumed them) included tea with nothing added (1), coffee with milk and sugar (4), two beers (1), a bag of microwaved popcorn (1), glass of milk (1), and ice cream with chocolate syrup (1). Although reported at the time of the dietary recall, these food items were not included in the data analysis because we assess the accuracy of this portion of their recall. We did not exclude these men from the statistical analysis. The analysis of recall of specific foods will be discussed elsewhere.

Figure 2 contains a Bland-Altman plot (12,13) of the differences between actual and recalled energy intake against the average of actual and recalled energy intake. This plot illustrates the variability of the underestimation and overestimation of food intake by individual subjects throughout the range of energy consumed, but no significant methodologic bias can be detected. Ten men underestimated energy intake, and 32 men overestimated energy intake. The difference between recalled and actual energy intake fell between ±2 SD for all of the subjects.

Body Composition and Accuracy of Recall

The differences between recalled and actual intakes are plotted against BMI in Figure 3. Men throughout the BMI range overestimated and underestimated food intake; however, the highest overestimations were among the men with a BMI below 30. We found no relationship between BMI and accuracy of recall using the ANCOVA analysis described above (R^2=.01; P=.44); therefore, the data are presented for the group as a whole.

Percent Macronutrient Intake

We found no significant differences between actual and recalled intake, respectively, for the percent of energy intake from the macronutrients protein (14.4%±0.4% vs 14.3%±0.4%), carbohydrate (50.9%±1.4% vs 51.3%±1.3%), or fat (36.8%±1.3% vs 36.5%±1.2%).

Energy Intake on 1 Day as Representative of Habitual Intake

Using correlation analysis, we found a significant relationship between actual energy intake and EER (R=0.56; P<.001). Mean actual energy intake was not significantly different from mean EER (t test; P>.05). Figure 4, via a second Bland-Altman plot (12,13), illustrates that on the 1-day study only five men were outside the 2-standard deviation limits of agreement between energy intake and EER.

Using the EI:BMR cut-off values (15) to evaluate the minimal plausible ratio for habitual EI:BMR, we found that 10 men had EI:BMR ratios at or below the cut-off value of 1.38, but once again there was no apparent pattern with respect to BMI (Figure 5). These cut-offs offer a second method of identifying those 10 men who underate on the day of observation. Taken together, Figures 4 and 5 suggest that on average the energy intake on this 1 day of study seems to be representative of habitual energy intake.

DISCUSSION

National surveys are conducted by the USDA and DHHS to provide nutrient intake data to federal agencies and the private sector for purposes of scientific research, monitoring, surveillance, regulation, establishment, and oversight of nutrition-related programs and population-based standards (1-5). In this study we used a criterion method, direct observation, to evaluate the validity of the multiple-pass method for dietary recall in men.

Accuracy of Recall

To test the accuracy of dietary recall, we used both ANCOVA (Table 2) and a statistical method devised by Bland and Altman (12,13) (Figures 2 and 4). The major finding of this study is that the USDA five-step multiple-pass method was an effective means of assessing dietary energy and macronutrient intake within 10% of the actual energy intake in this population of men. Furthermore, we found that energy intake was not assessed as well on an individual basis, as seen in the variation in the difference between recalled and actual intakes of energy, protein, carbohydrate, and fat in Table 2. These data are in agreement with those of our previous study under similar conditions in women (6) and studies by others (7,8,19). Johnson and colleagues (7) reported that the multiple-pass method was accurate in assessing group energy but not individual energy intakes. Karvetti and

Table 2. Mean actual, recalled, and difference (Δ) between actual and recalled intakes of energy, protein, carbohydrate, and fat (n=42)							
	Actual Intake		Recalled Intake		Difference Between Actual and Recalled Intakes		
	$\bar{x}\pm$SEM[a]	Range	$\bar{x}\pm$SEM	Range	Δ[b]$\bar{x}\pm$SEM (*P* value)	Δ[c] range	%Δ$\bar{x}\pm$SEM
Energy (kcal/d)	3,294±111	1,797-4,707	3,541±124	1,816-5,349	247±67 (0.2)	−456-1,311	8.1±0.6
Protein (g/d)	117±4.6	71-186	126±5.3	77-206	8.1±3.0 (0.4)	−21-53	8.1±0.7
Carbohydrate (g/d)	414±16	226-818	449±16	236-727	33.9±8.6 (0.2)	−91-164	9.3±0.6
Fat (g/d)	136±7.3	50-252	146±8	55-251	9.6±3.3 (0.2)	−28-57	8.0±0.6

[a]$\bar{x}\pm$SEM=mean±standard error of the mean.
[b]Δ=[Recalled intake−Actual intake] calculated on a per subject basis.
[c]A negative value indicates an underestimation; a positive value indicates an overestimation.

Knuts (19) found a −6% to 11% difference between recalled and actual intake in a study of 84 male and 56 female subjects. This variation is similar to that found in our study.

Body Size and Accuracy of Recall

Unlike our earlier study in women (6), there was no difference in the accuracy of dietary recall among men differing in BMI by ANCOVA analysis and as illustrated in Figure 3. Recently Hill and Davies (20) reviewed the growing body of work comparing self-reported energy intake from 24-hour dietary recalls, food frequency questionnaires, and food records to energy expenditure estimations from doubly labeled water. They found significant underreporting of energy intake coupled with self-reporting of food intake in free-living individuals, and they suggest that this underreporting may be because of factors not limited to body size and adiposity. They suggest that issues related to dietary restraint and socioeconomic status may affect accuracy of self-reporting.

Although our findings differ from some others, it was our intention to test the ability of the method to assess recall under the "ideal" or controlled conditions of our study. Disparities reported from studies on free-living individuals, or in populations selected on the basis of their inability to lose weight or body size, may be attributable in part to problems that arise under the field conditions of each study. These problems may include a generalized lack of awareness of food intake when one is maintaining typical fast-paced living patterns or a social-desirability (21) driven consumption of "healthier" kinds and amounts of foods, or more accurate reporting of foods while participating in a nutrition study.

The men's food intake was assessed for only 1 day; however, the metabolic setting in which the study was conducted afforded significant accuracy in determining the actual food consumed, while allowing the men to participate in their daily routines. One dietitian conducted all of the dietary recalls, and a second nutritionist, who had been trained following the guidelines used for conducting the USDA national survey, coded the actual and recalled food intake records. Our statistical power calculations indicated that we had more than 80% power to detect a difference between actual and recalled intakes, despite the relatively small sample size.

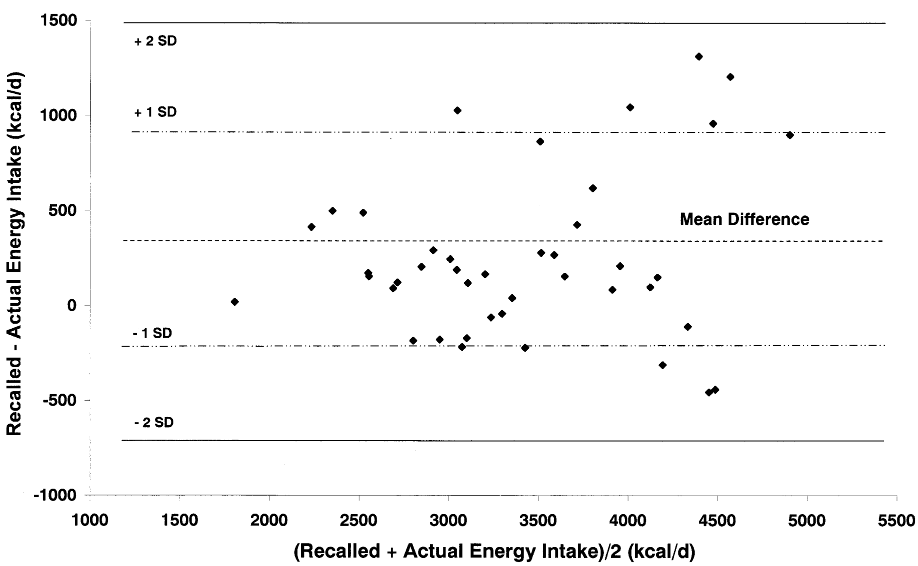

Figure 2. Bland-Altman plot of the mean difference between recalled and actual energy intake (kcal/day; x-axis) vs the mean of the recalled and actual energy intake (kcal/day; y-axis), indicating ±1 and 2 standard deviations from the mean difference (n=42). The limits of agreement, as defined by Bland and Altman (13,14), which equal 2 standard deviations of the difference above and below the mean difference, are plotted. The mean difference between recalled and actual energy intake is indicated by the dashed line.

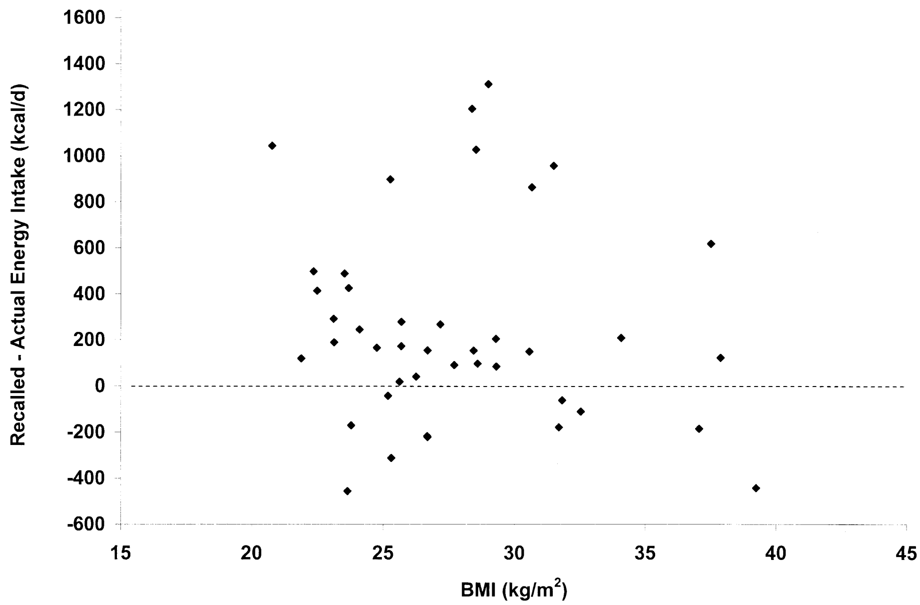

Figure 3. Difference of recalled minus actual energy intakes plotted against body mass index (n=42).

The artificiality of the observational conditions may have affected the food intake and/or the ability of the men to recall their food intake. Although one study (22) found a high interclass correlation between food consumed in the laboratory and habitually, we do not know the effect that eating under our controlled conditions had on the men. It is possible that their cognitive involvement while selecting foods and eating them in our dining room made it easier for the men to recall food intake. This is noteworthy because an increasing percentage of meals are eaten away from home among Americans (23). Whether or not these results would apply to the recall of foods selected and eaten away from home in large-scale surveys remains to be proven. Furthermore, because the study population was composed of white men with a mean of 14 years of education, study findings may not be generalizable to the American population as a whole.

Estimated Energy Requirements

Comparison of the actual energy intake with the estimated energy requirements in Figure 4 indicates that these men ate below, above, or at their energy requirements on the day of study. However it can be said that the mean actual energy intakes of these men were found to be representative of their energy requirements from the re-

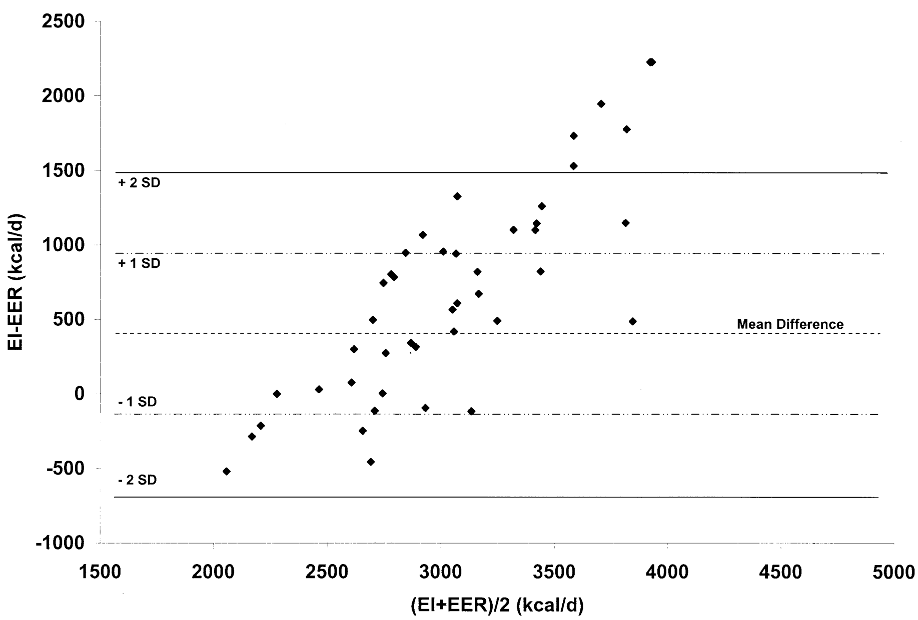

Figure 4. Bland-Altman plot of the mean difference between actual energy intake and estimated energy requirements (kcal/day; x-axis) vs the mean of the actual energy intake and estimated energy requirements (kcal/day; y-axis), indicating a ±1 and 2 standard deviations from the mean difference (n=42). The limits of agreement as defined by Bland and Altman (13,14), which equal 2 standard deviations of the difference above and below the mean difference, are plotted.

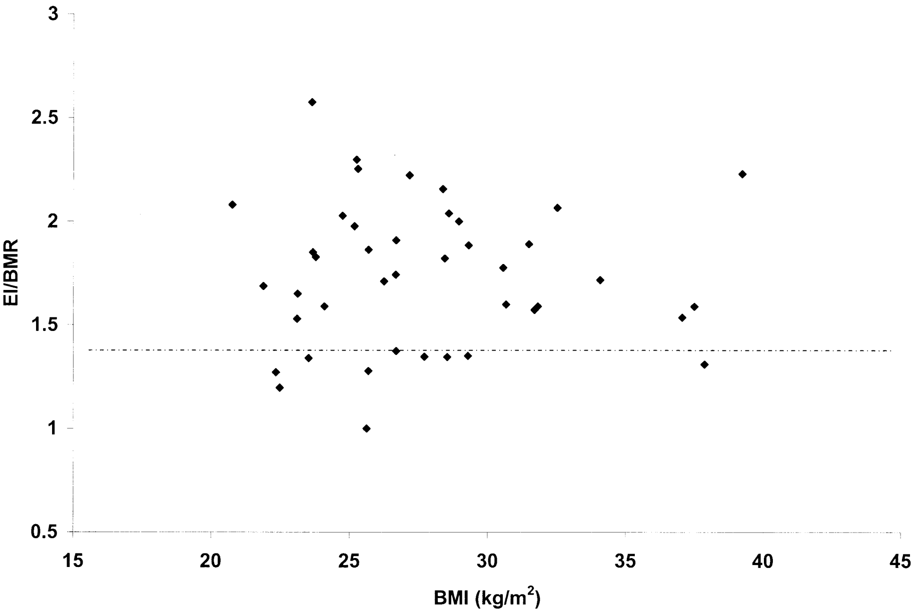

Figure 5. Ratio of energy intake to estimated basal metabolic rate (EI:BMR) vs body mass index (n=42). The dashed line indicates the cut-off value of 1.38.

cently published EER equations (14). This finding, coupled with the EI:BMR data presented in Figure 5, that most men ate above the cut-off value of 1.38, suggests that in this population mean actual energy intake was representative of habitual energy intake or their energy requirements.

CONCLUSIONS

- Under controlled conditions, the USDA five-step multiple-pass method can accurately assess intakes of energy, protein, carbohydrate, and fat in a population of men regardless of their BMI. It is a practical method for estimating the energy intake of groups.
- Because of the significant variation in the ability of the men to recall food intake, individual dietary intake may remain difficult to assess by the 24-hour dietary recall method.
- Researchers and clinical dietitians need to continue to examine factors that influence underreporting and overreporting of food intake using the multiple-pass 24-hour recall method under field conditions.

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